

Assessment of Bioaccumulation Risks in San Diego Bay: Human Health Risk

Steven Bay

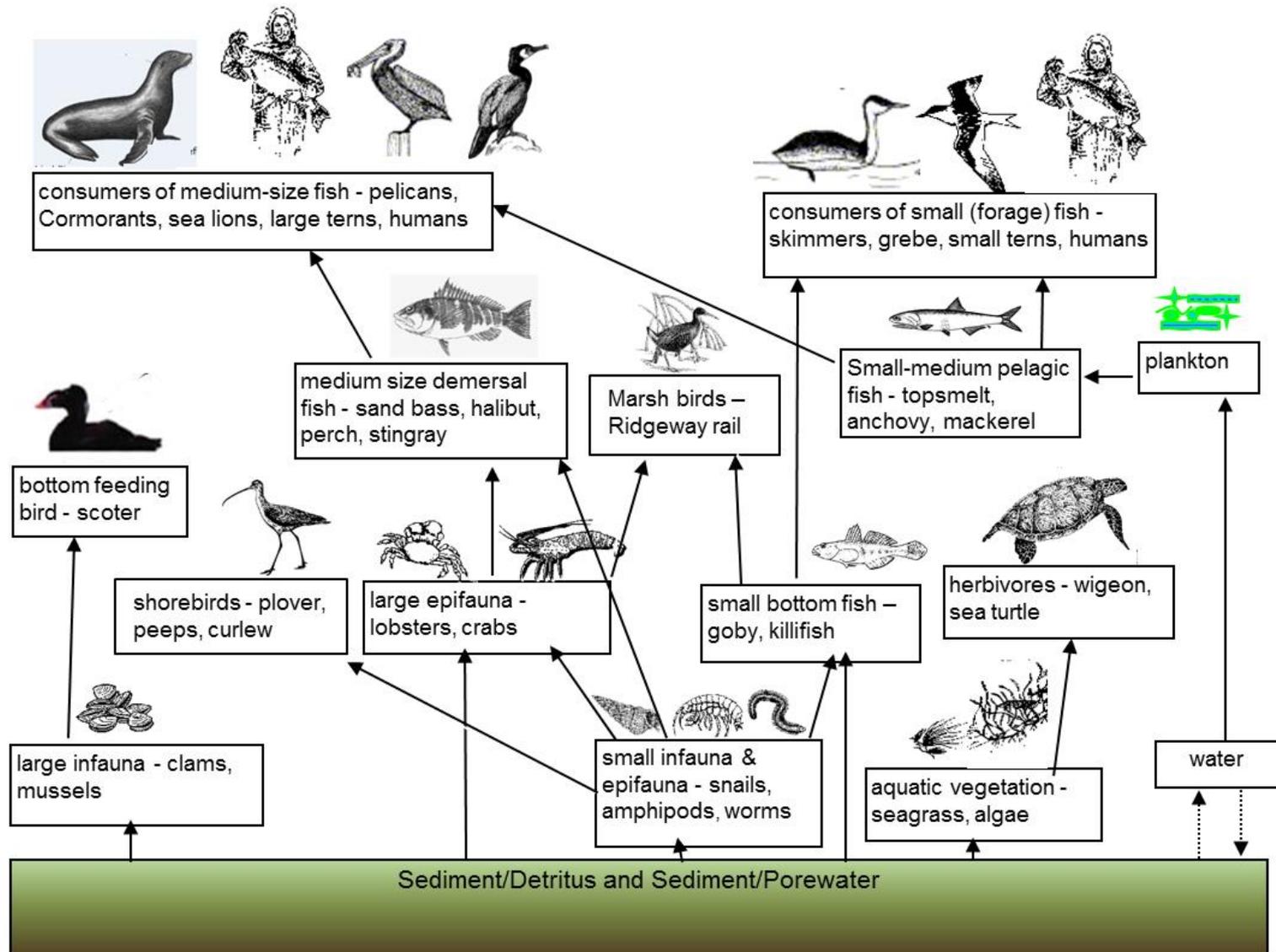
Southern California Coastal Water Research Project

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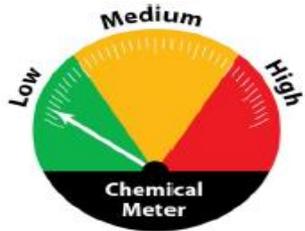


San Diego Bay Exposure Pathways



A Healthy Guide to Eating Fish from San Diego Bay

Women 18-45 years and children 1-17 years



Diamond turbot



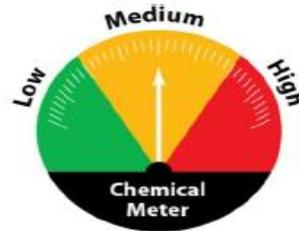
Spotted turbot



Black perch
Pile surfperch
Rainbow seaperch



California lizardfish



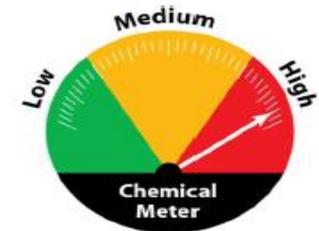
Pacific chub mackerel



Round stingray



Shovelnose guitarfish



Spotted sand bass



Topsmelt



Leopard shark



Gray smoothhound shark



Barred sand bass



Shiner perch



Yellowfin croaker

2 servings a week



1 serving a week

Do not eat

Human Health Risk Evaluation

- **Collected samples of common sport fish**
 - Spotted sand bass, halibut, topsmelt, round stingray
 - PCBs, DDTs, chlordanes, dieldrin
- **Sampling in 2014 and 2015**
 - Boats, piers, and shore
- **2 types of analyses**
 - Comparison to seafood advisory tissue levels
 - Evaluation of potential cancer risk and linkage to sediment contamination

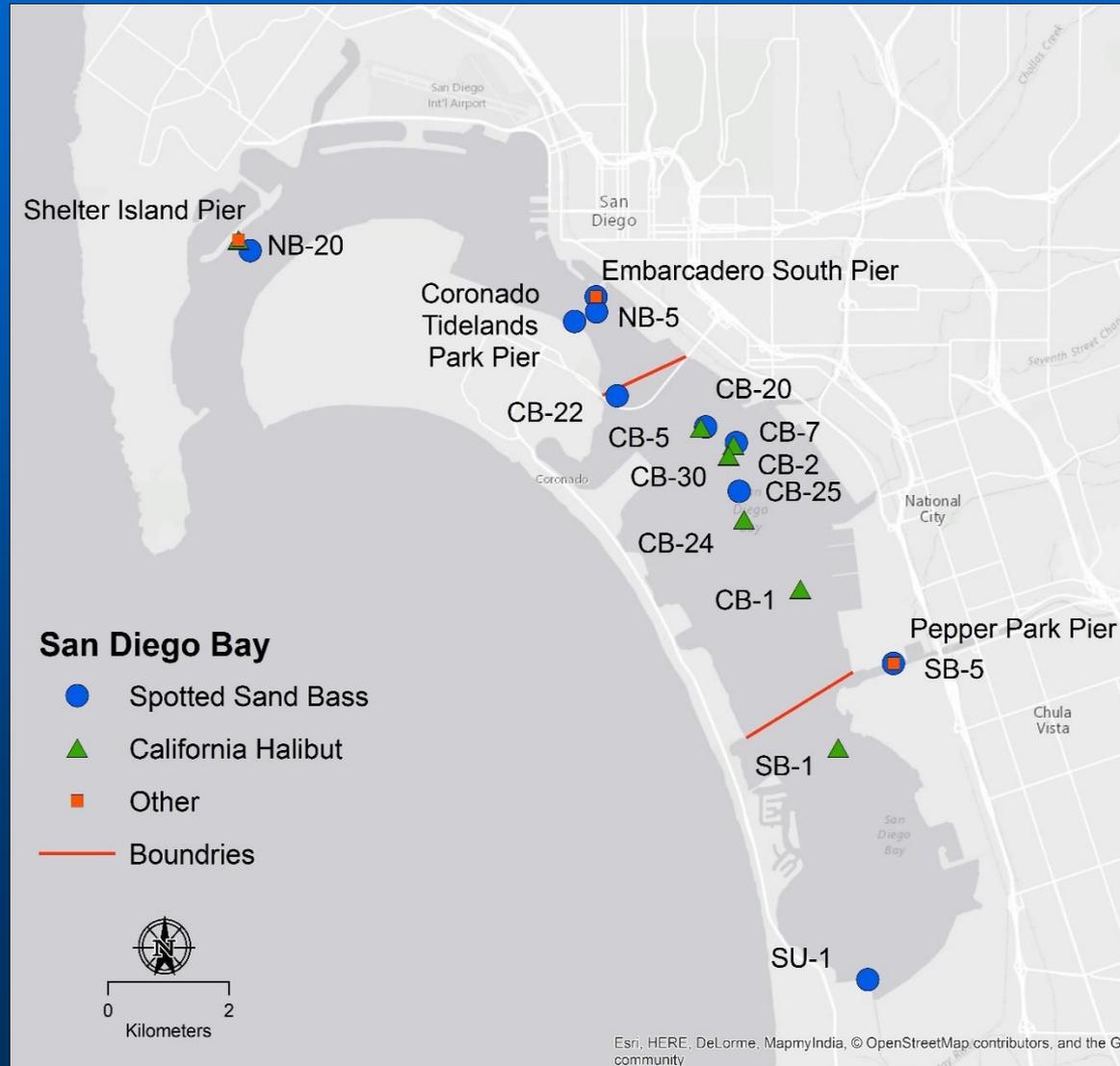
Sport Fish Sample Summary

- **Halibut and spotted sand bass collected from three regions of Bay**
 - Combination of boat, pier, and shore locations
- **Other species from piers only**
- **Composite samples analyzed for most species (except halibut)**

Sample Group	Common Name	Count
Sport fish	California halibut	8
	Pacific chub mackerel	3
	Round stingray	2
	Spotted sand bass	9
	Topsmelt	1
	Sport Fish Total	

Sport Fish Sample Locations

- Chemical analysis for PCBs, DDTs, mercury, Chlordanes, and dieldrin
- Composites of 5 fish
 - Individual halibut
 - Fillet or whole body (depending on size)



Health Risk Assessment Methods

- **OEHHA threshold comparison**
 - Basis for seafood consumption advisories
 - Balance health risk and benefits of seafood consumption
 - Does not consider source of contamination
- **Sediment Quality Objectives draft assessment framework**
 - Determines whether sediment contamination has unacceptable impact on human health
 - Linkage of health risk to sediment contamination source
 - Preliminary evaluation; thresholds not yet adopted

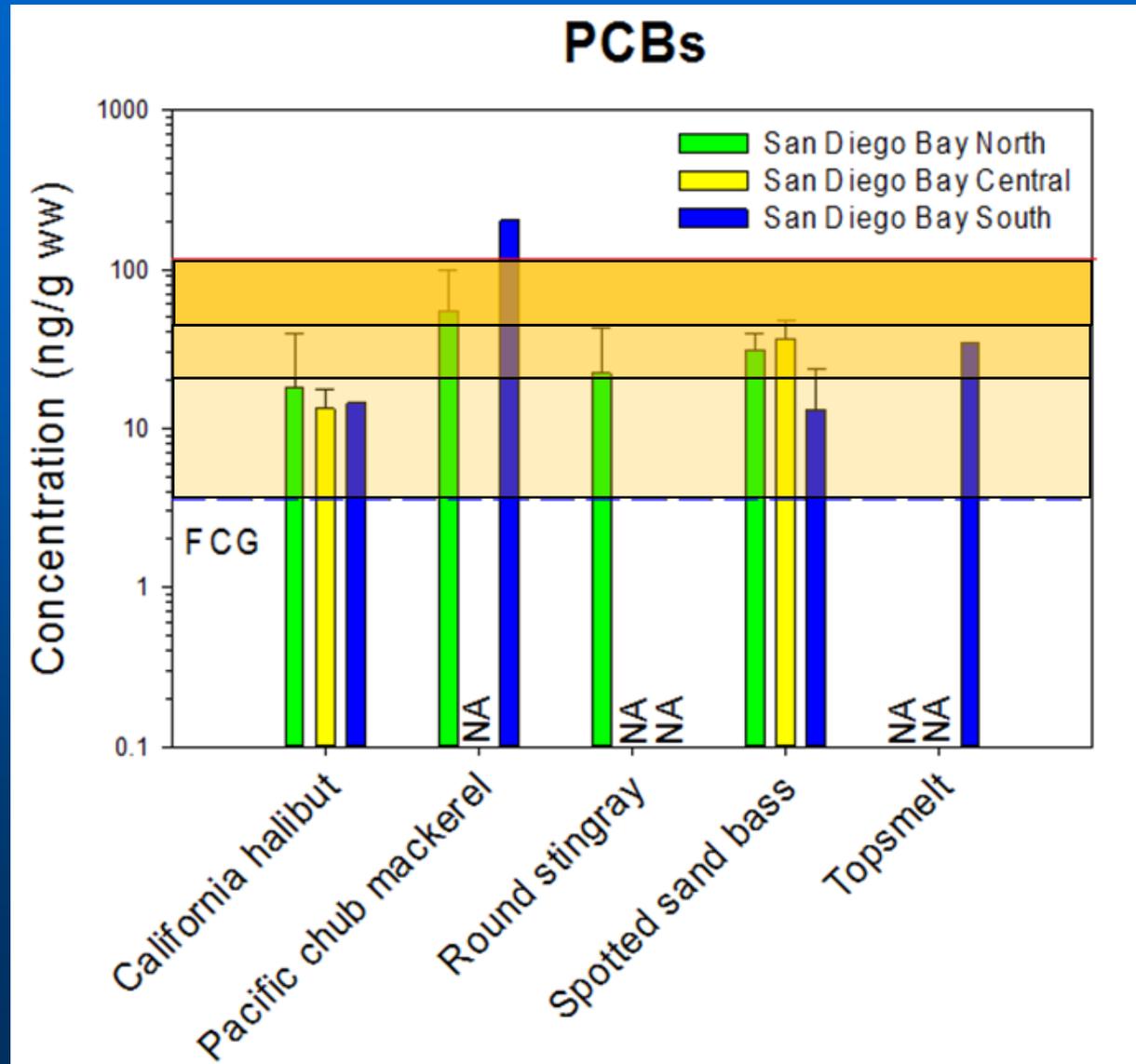
OEHHA Thresholds

Contaminant	FCG	ATL for 8 oz Serving Size (ng/g)			
		3 servings per week	2 servings per week	1 serving per week	No Consumption
Chlordanes (ng/g)	5.6	≤ 190	> 190-280	> 280-560	> 560
DDTs (ng/g)	21	≤ 520	> 520-1000	> 1000-2100	> 2100
Dieldrin (ng/g)	0.46	≤ 15	> 15-23	> 23-46	> 46
Mercury ¹ (ng/g)	220	≤ 70	> 70-150	> 150-440	> 440
Mercury ² (ng/g)	655	≤ 220	> 220-440	> 440-1310	> 1310
PCBs (ng/g)	3.6	≤ 21	> 21-42	> 42-120	> 120

- **Fish Contaminant Goal: No significant health risks over lifetime of seafood consumption**
- **Advisory Tissue Level: Balance of benefits and risk of seafood consumption**
 - Basis for OEHHA fish consumption guidelines
 - Age and gender-specific for mercury

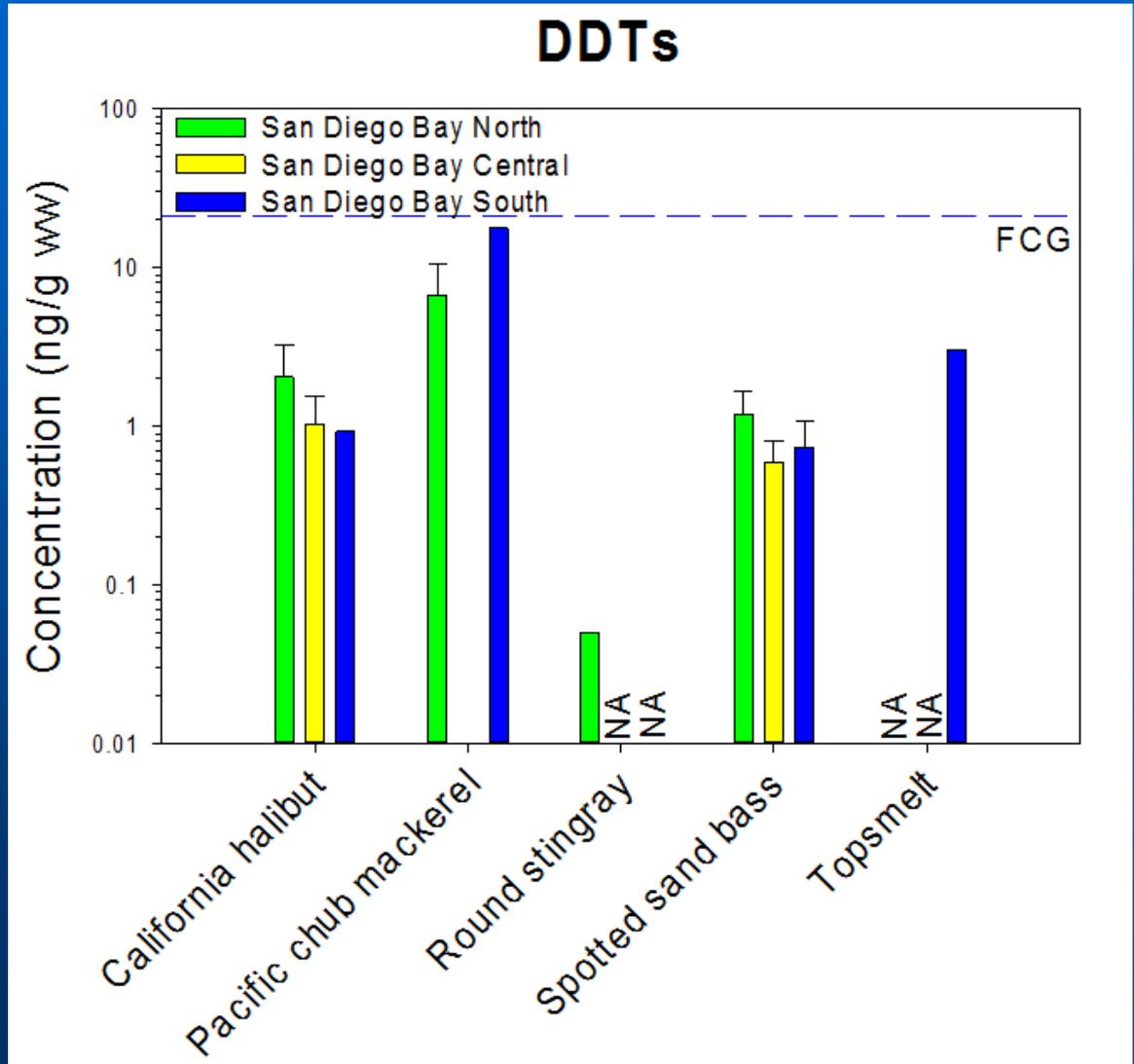
PCBs

- Thresholds for limited consumption exceeded by all fish
- Greatest potential risk for mackerel



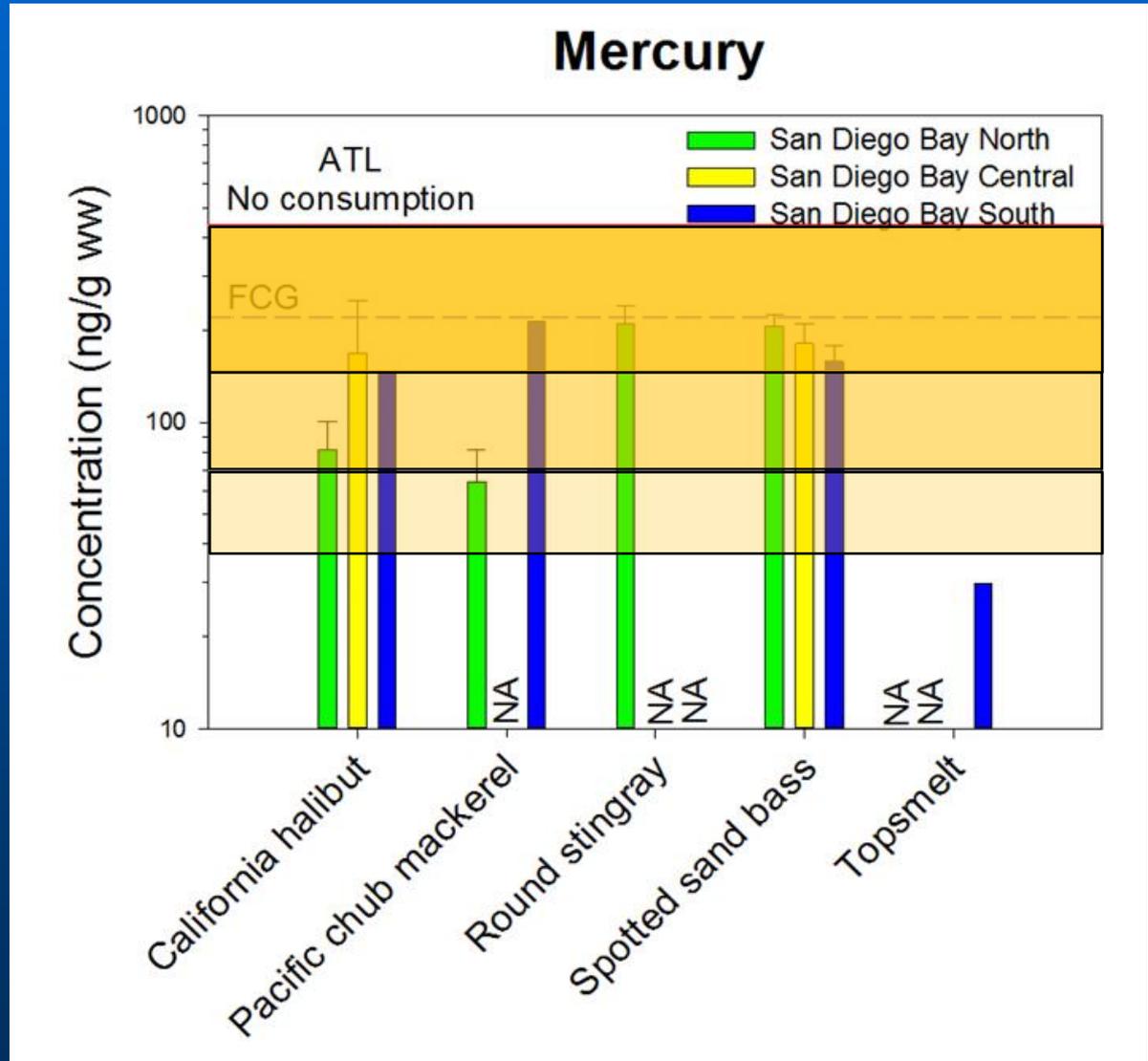
DDTs

- All samples below OEHHA Fish Contaminant Goal



Mercury

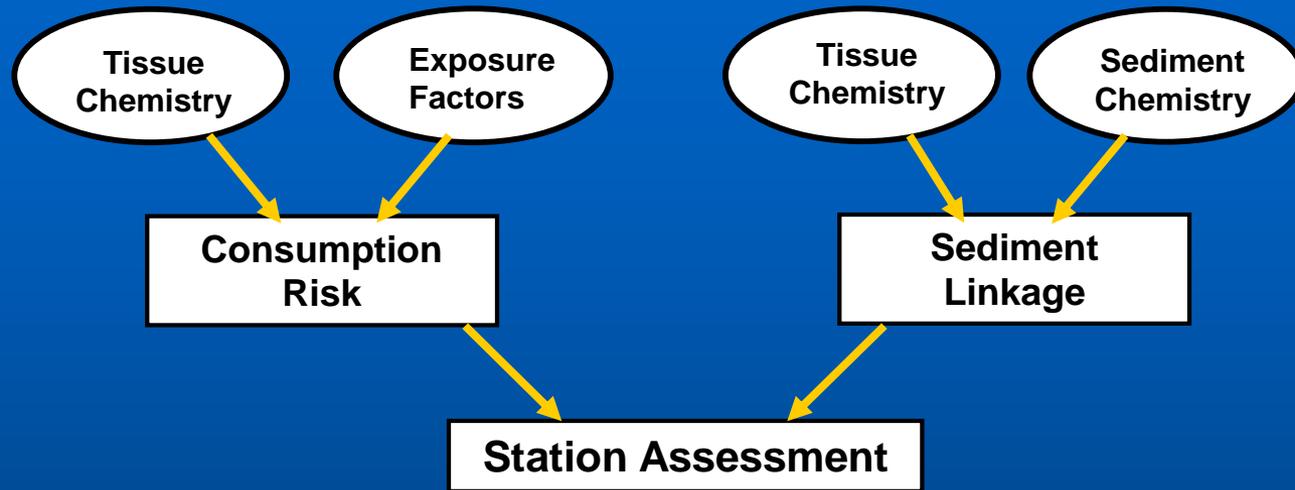
- Thresholds for limited consumption by children and young women (18-45) exceeded for most fish



SQO Assessment Framework

- **State Water Board has adopted a narrative sediment quality objective (SQO) for protection of human health**
- **Assessment framework to determine attainment of SQO under development**
 - **Thresholds and methodology under refinement**
 - **Staff report and public review planned for early 2017**
- **San Diego Bay bioaccumulation data used as case study**

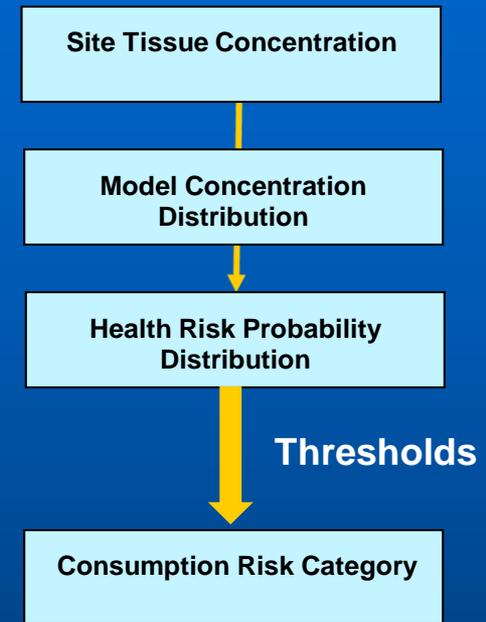
Assessment Framework for Human Health Impacts



- **Considers both consumption risk and sediment linkage**
 - Both indicators must exceed thresholds to identify impacts
- **Categorical outcome**
 - Similar structure as for aquatic life SQO assessment framework
 - Facilitates use in monitoring and regulatory programs

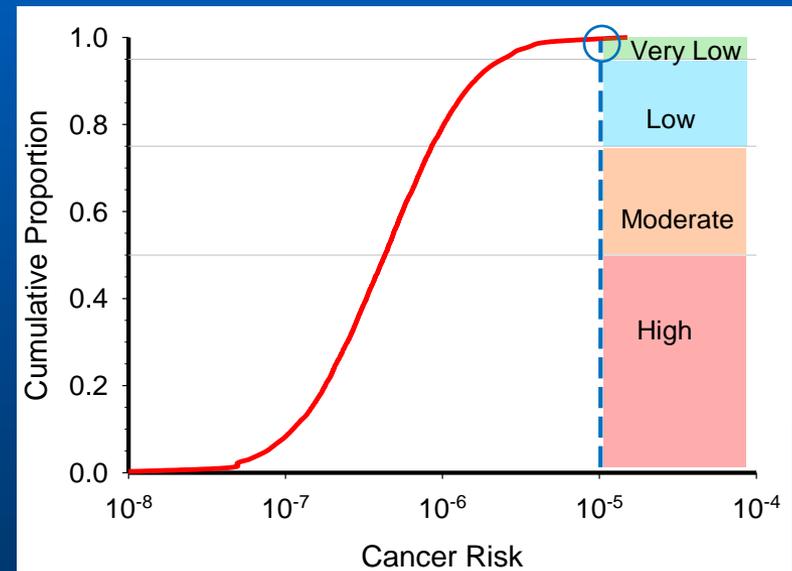
Consumption Risk Indicator

- Risk calculation based on tissue contaminant concentration
 - Cancer risk
 - Noncancer hazard quotient
- Tissue concentration based on integrated data for site
 - Multiple stations
 - Multiple species
- Monte Carlo simulation of exposure parameters to generate risk distribution
 - Proportion exceeding threshold determines risk category
 - Provisional thresholds
 - 10^{-5} additional cancer risk (1:100,000)
 - Hazard quotient > 1



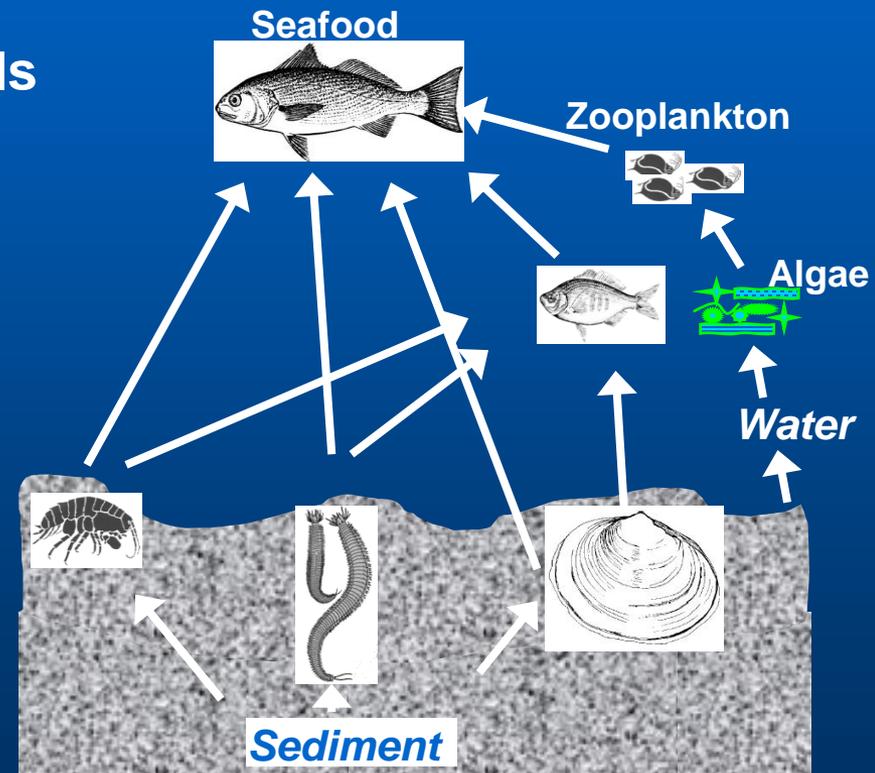
Consumption Risk Evaluation Approach

- Based on modeled distribution of health risk
 - Monte Carlo simulation based on variability in tissue chemistry and consumption rate
 - Proportion of distribution above threshold determines risk category
- Exposure parameters
 - One seafood meal per week consumed
 - Other parameters equivalent to OEHHA methods



Sediment Linkage

- Determines influence of site sediment on seafood tissue contamination
- Food web bioaccumulation models used to estimate site-associated bioaccumulation in fish
 - Biota Accumulation Factor (BAF)
- Linkage Factor =
$$\frac{\text{est. seafood conc}}{\text{measured conc at site}}$$
 - Proportion exceeding threshold determines linkage category



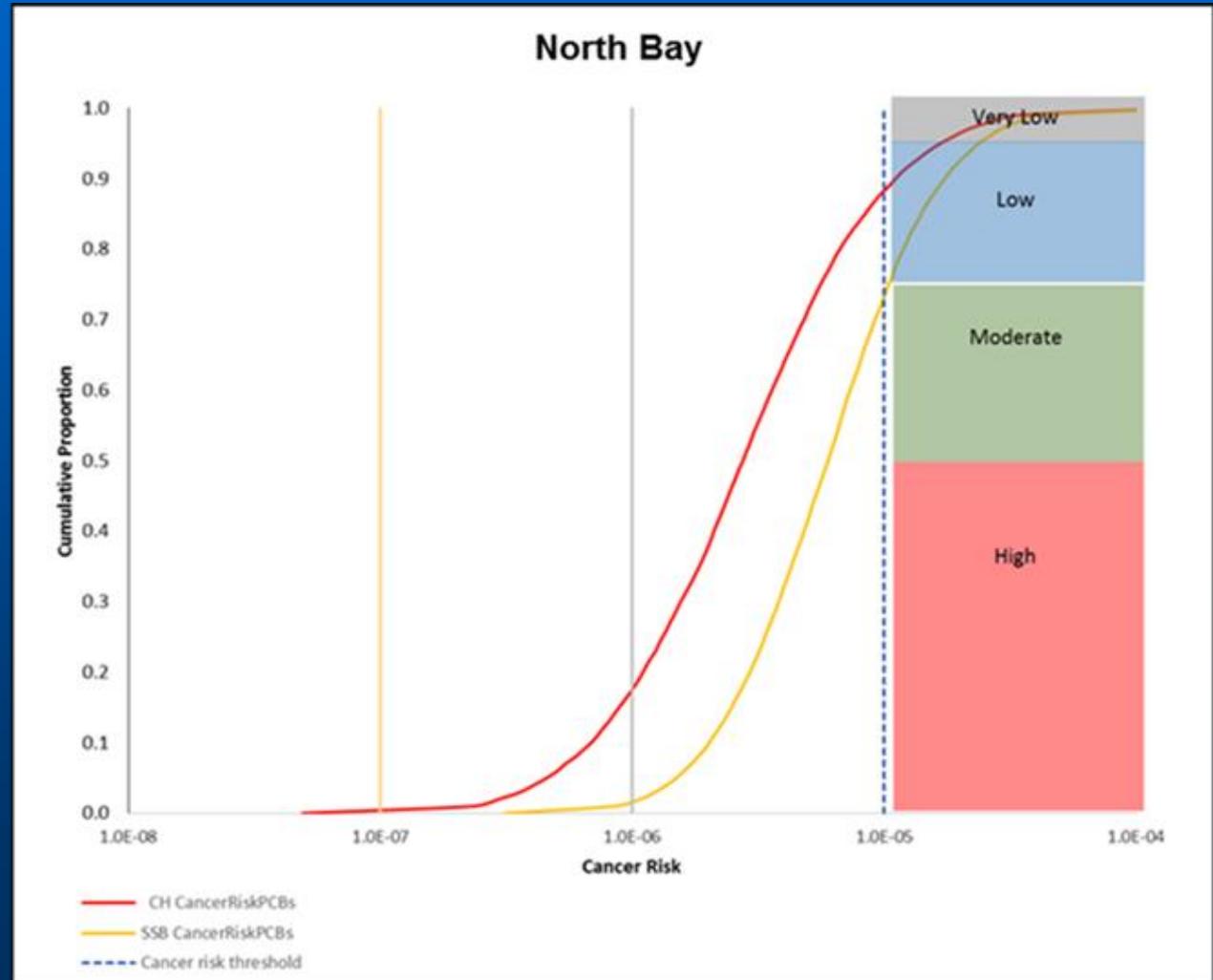
Site Assessment

- **Classification criteria reflects two key principles**
 - Can't exceed SQO if health risk is low
 - Evidence of site sediment linkage needed to exceed SQO
- **Provisional relationships shown**
 - Subject to Water Board approval

Consumption Risk	Sediment Linkage	Site Assessment
1. Very Low	1. Very Low	Unimpacted
1. Very Low	2. Low	Unimpacted
1. Very Low	3. Moderate	Unimpacted
1. Very Low	4. High	Unimpacted
2. Low	1. Very Low	Unimpacted
2. Low	2. Low	Unimpacted
2. Low	3. Moderate	Likely Unimpacted
2. Low	4. High	Likely Unimpacted
3. Moderate	1. Very Low	Likely Unimpacted
3. Moderate	2. Low	Possibly Impacted
3. Moderate	3. Moderate	Likely Impacted
3. Moderate	4. High	Clearly Impacted
4. High	1. Very Low	Likely Unimpacted
4. High	2. Low	Possibly Impacted
4. High	3. Moderate	Likely Impacted
4. High	4. High	Clearly Impacted

Estimated PCB Cancer Risk: North

- Highest potential cancer risk from eating spotted sand bass
- Relatively low risk overall
 - Less than 1 in 100,000 additional cancer case risk for most consumers

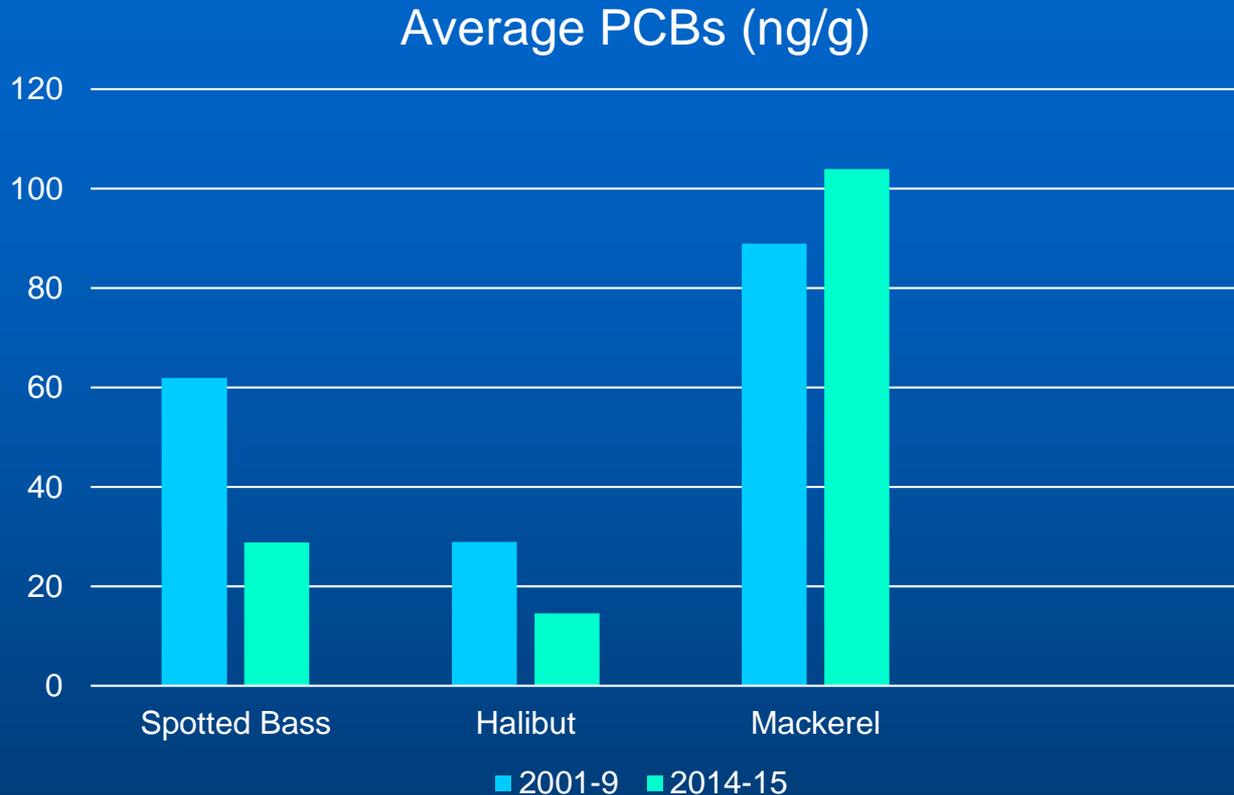


Preliminary SQO Assessment

	Percentage of Distribution				
Indicator	25%	50%	75%	95%	Category Outcome
Chlordanes					
Cancer Risk		1.1×10^{-8}	1.9×10^{-8}	4.5×10^{-8}	Very Low
Noncancer Hazard		5.8×10^{-4}	1.0×10^{-3}	2.5×10^{-3}	Very Low
Sediment Linkage	2.8	3.7	4.7		High
Site Assessment Outcome					Unimpacted
DDTs					
Cancer Risk		2.6×10^{-8}	4.7×10^{-8}	1.1×10^{-7}	Very Low
Noncancer Hazard		3.5×10^{-4}	6.5×10^{-4}	1.6×10^{-3}	Very Low
Sediment Linkage	1.0	1.4	2.0		High
Site Assessment Outcome					Unimpacted
PCBs					
Cancer Risk		2.5×10^{-6}	4.5×10^{-6}	1.1×10^{-5}	Low
Noncancer Hazard		0.1	0.3	0.6	Very Low
Sediment Linkage	1.9	2.4	3.0		High
Site Assessment Outcome					Likely Unimpacted

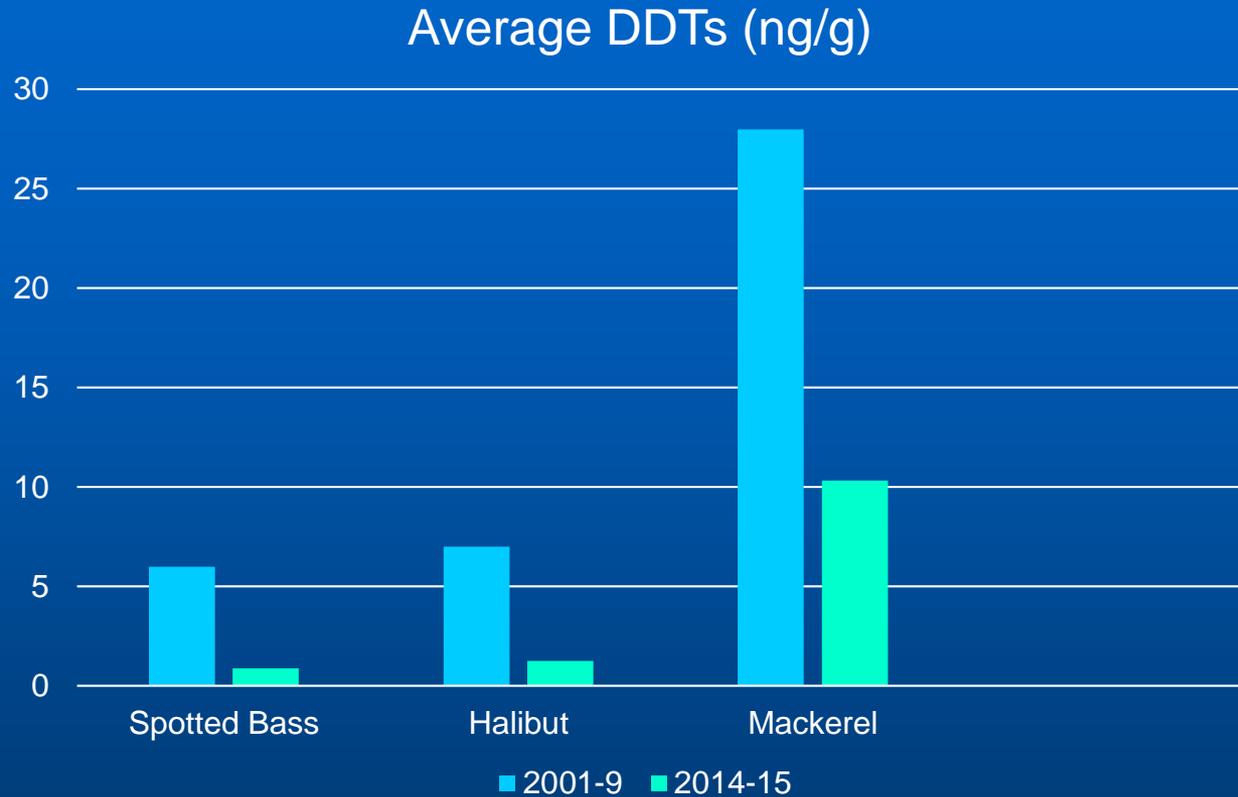
- Results based on spotted sand bass and California halibut for entire bay

Temporal Trends



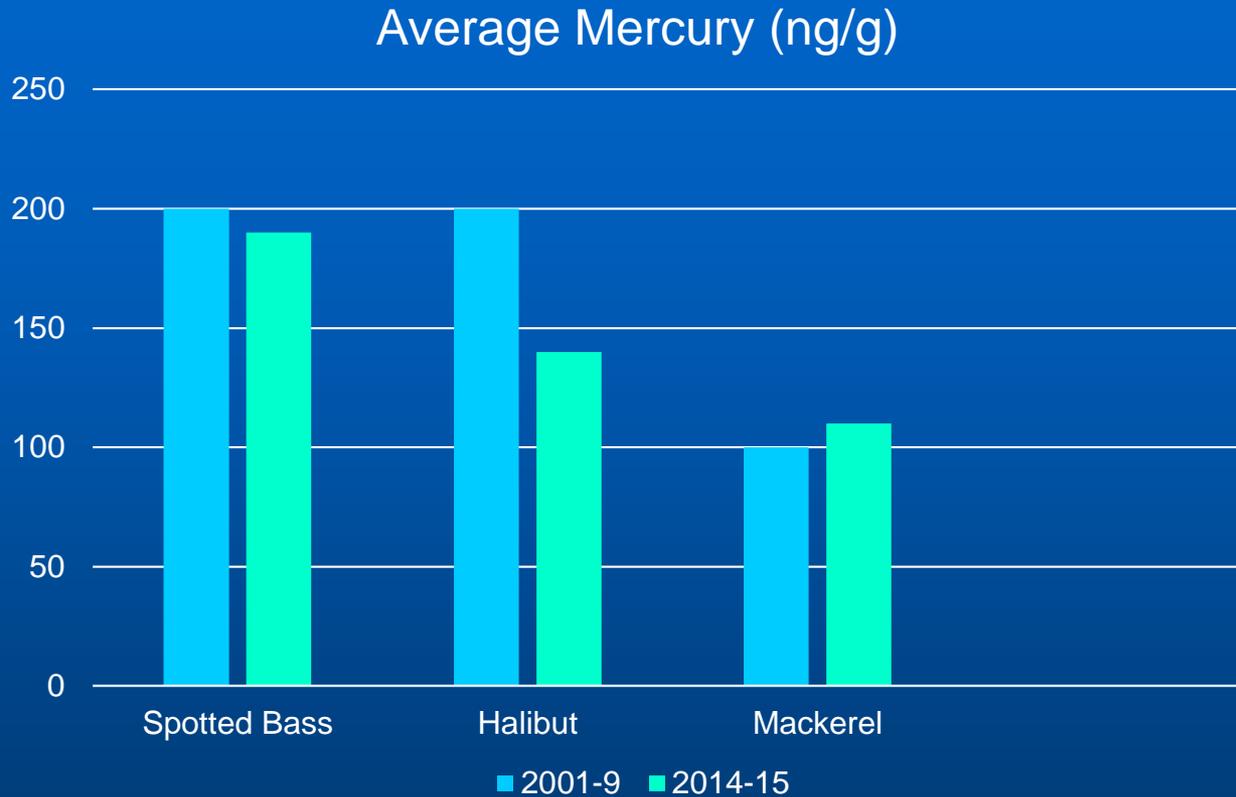
- **Reduced tissue burden, relative to OEHHA data set**
- **Different trends for mackerel likely reflect sources outside of San Diego Bay**

Temporal Trends



- **Greater temporal change than PCBs**

Temporal Trends



- Little temporal change for all species evaluated

Summary

- **PCBs are dominant trace organic contaminant of Bay seafood**
- **Similar fish contamination levels among Bay regions**
- **Greatest potential human health risk associated with PCBs**
 - Consumption limits still indicated for PCBs and mercury
- **Tissue contamination for PCBs and DDTs declining**
 - Management actions having an effect

Next Steps

- **Final report completion**
 - Draft report available from Water Board
 - Report review in progress
 - Final report planned for November 2016
- **Project data release**
 - CEDEN (in progress)
 - Project data set (in preparation)
 - Available from SCCWRP and Water Board